Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

MINING RESEARCH PROJECTS

(EXCEPT FOR COAL)

FY 1988–1989

MINING RESEARCH LABORATORIES
DIVISIONAL REPORT MRL 88–58(TR)E

Canada

89-02918/

MINING RESEARCH PROJECTS

(except for coal)

Fiscal Year 1988-1989

MINING RESEARCH LABORATORIES
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Ottawa, Ontario
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Laboratories at:
Bells Corners Complex
Nepean, Ontario
and
Elliot Lake, Ontario

MICRO

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MRL 88-58(TR)
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Foreword

This report contains summaries of all of the research projects which will be undertakep by the staff of the Mining Research Laboratories, of CANMET, Department of Energy, Mines and Resources, during the 1988-1989 fiscal year. The document is intended to complement the Division's Annual Report and to serve as an additional means of making MRL's research plans known.

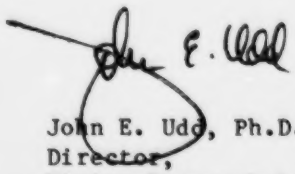
The format follows parallels that were used by sister Divisions of CANMET. Each project is described by means of statements of objectives, background, and activity planned for the coming year. To facilitate further contacts the names and telephone numbers of the various project leaders are given.

The work of the Division involves the full-time in-house efforts of a staff of approximately 90 persons. Its mandate includes all mining research except for that devoted to carbons and hydrocarbons. Those are the responsibility of the Coal Research Laboratories, with headquarters in Devon, Alberta.

In addition to their own research, MRL staff are also responsible for the supervision of research contracts. Largely as the result of the Mineral Development Agreements between the Federal and Provincial governments, the number of such projects has increased rapidly. In dollar terms almost 50% of the funds allocated to the Division are now devoted to the contracting of significant parts of the research program to the private sector. The trend is towards external large-scale field demonstration-type projects. As a result, MRL's contacts with the mining industry are becoming better and better.

A list of the research contracts in effect for the current year is given as Appendix A to the report.

Since the purpose of this document is to facilitate the dissemination of information, responses to it are invited. Either the undersigned or the project leaders listed would be pleased to try to answer questions and to try to provide any further information that may be required.



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Avant Propos

Le présent rapport comprend des résumés de tous les projets de recherche qui seront entrepris au cours de l'année financière 1988/1989 par le personnel des Laboratoires de recherche minière de CANMET, Énergie, Mines et Ressources Canada. Le document se veut un complément du Rapport annuel de la division et un moyen de faire connaître les projets de recherche de LRM.

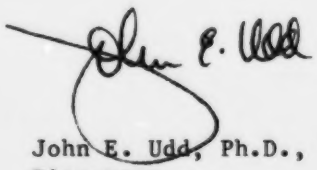
Le rapport est présenté dans un format semblable à celui des rapports produits par les autres divisions de CANMET. La description de chaque projet comprend un exposé des objectifs, un état de la situation et les activités prévues pour l'année à venir. Les noms et numéros de téléphone des chefs des différents projets sont présentés en vue de faciliter les contacts.

Les travaux de la division sont réalisés par un effectif d'environ 90 personnes qui travaillent à temps plein. Le mandat de la division comprend toutes les activités de recherche minière, exception faite de celles portant sur le carbone et les hydrocarbures. La réalisation de ces dernières incombe aux Laboratoires de recherche sur le charbon dont le siège social est à Devon, en Alberta.

Le personnel de LRM qui a ses propres activités de recherche doit, en outre, assurer la supervision des contrats de recherche. En raison des ententes fédérale-provinciales sur le développement minéral, le nombre des projets de recherche n'a cessé d'augmenter. Financièrement, cela se traduit par l'allocation d'environ 50% des fonds de la division à la réalisation en sous-traitance, dans le secteur public, d'une partie importante du programme de recherche. Étant donné qu'à l'heure actuelle la tendance favorise les grands projets de démonstrations sur le terrain, les contacts de LRM avec l'industrie minière se sont améliorés considérablement.

La liste des contrats de recherche accordés pendant l'année en cours est présentée à l'annexe A.

Le but de ce rapport étant de faciliter la dissémination de l'information, tout commentaire sera apprécié. Les chefs de projets dont les noms figurent sur la liste ainsi que moi-même serons heureux de répondre à vos questions et de vous fournir, le cas échéant, toute information supplémentaire pouvant vous être utile.



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ADMINISTRATION OF THE CANADA EXPLOSIVES ACT

CERTIFICATION AND TECHNICAL ADVICE

Project Leader: F. Contestabile
(613) 995-1363

Person-Years: 8.0
A-Base Operating and Maintenance: $400,000
Contracts: Nil

Objective:

On a continuing basis: to confirm the safety characteristics of all explosives submitted annually for authorization under the Canada Explosives Act; to provide technical advice on the manufacture, storage and transportation of explosives, and to investigate accidents.

Background:

All explosives products, including ammunition and fireworks, must be authorized under the Canada Explosives Act prior to use in Canada. New explosives submitted for authorization need to be evaluated to assess any peculiar safety hazards related to the product, their manufacture, transportation, storage and use. This testing and evaluation is done at CANMET. Those explosives which do not present unusual hazard are recommended for authorization. In addition, production explosives are monitored to ensure that prescribed standards are met.

As new types of explosives are developed, new test standards need to be developed to ensure proper and reliable evaluation of possible hazards before they can be used.

Technical advice on explosives and explosion hazards is provided to various government departments and agencies, industry, and the public. Accidental explosions are investigated on an "as required" basis.

Technology Transfer:

1. Organizations Involved: Authorization of explosives, technical advice and accident investigations are services provided to federal departments, provincial governments, industry, and the general public.

2. Mode of Technology Transfer: Reports, meetings, telephone calls.

3. Time Frame: Fiscal year 1988/89.

4. Specific Technology Transfer Goals:

   a) Improved quantity/distance storage tables for propellants - improved assessment of risk, minimize fatalities/injuries.

   b) Assessment of Class 7.2.2 display fireworks risk - more realistic assessment of hazards in storage/transport, minimize fatalities/injuries.

c) Fireworks Standards - improved quality fireworks, reduced risk to users (fewer injuries).

d) Forensic Transport Container - low risk container to transport forensic explosive samples to specialized analytical laboratory, enhanced response in criminal actions.

e) Schedule IV Container - enhanced safety for those trucks transporting both detonators and explosives.

Planned Activities for FY 1988/89:

1. The Canadian Explosives Research Laboratory will evaluate all submitted samples in 1988/89 (approximately 400 reports).

2. Technical advice on the manufacture, storage and transportation of explosives will be provided on an "as required" basis in 1988/89.

3. Investigation of accidental explosions will be on an "as required" basis in 1988/89.

4. a) Formalization of Canadian standards for pyrotechnics with industry.

   b) To review and, possibly, redesign the Schedule IV Container.

   c) To complete the risk assessment of Class 7.2.2 Fireworks.

   d) A review of factors that can affect the quantity-distance storage requirements for propellants.

EXPLOSIVES R&D

Project Leader: K.K. Feng
(613) 995-0139

Person-Years: 6.0
A-Base Operating and Maintenance: $391,000
Contracts: $10,000

Objective:

To advance technology related to the manufacture, storage, transportation and use of explosives.

Background:

Explosives R&D at CANMET is primarily directed at furthering our technical capability to reduce safety and health risks involved in working with explosives.

CANMET efforts over the past few years have been directed to the development of mathematical models to predict explosives properties and detonation parameters in order to avoid the need for extensive field testing of explosives to determine, for example, the levels of toxic fumes produced by detonation.

A new fume testing facility has been constructed to permit development of an improved industrial fume standard. The effects of temperature and fire on explosives during manufacture, storage and transportation are being investigated.

Methods to determine properties of explosives are continually being developed or improved as new types of explosives are marketed. In order to contribute to risk analysis methodology, new types of explosives are studied in depth to fully characterize them. CANMET will direct part of its research effort to the hazards associated with pyrotechnics and propellants.

An additional thrust will be the study of properties of explosives, including detonators, as related to their use in mining and civil engineering projects. These properties will include propagation sensitivity and time delay of detonators.

Technology Transfer:

1. Organizations Involved: Outputs are to develop knowledge and new techniques to identify explosive hazards. Preliminary recipients are the Canadian explosives industry and federal regulatory agencies.

2. Mode of Technology Transfer: Reports and seminars.

3. Time Frame: Specific outputs as noted below.

Planned Activities for FY 1988/89:

1. Review of the effects of detonator properties on rock fragmentation.

2. Establishment of a new fume testing facility and initial report on evaluation of detonation products.

3. Comparison of theoretical calculations of the detonation products of explosives with the experimental data from the CERL fume facility.

MINING METHODS AND EQUIPMENT

MINE METHODS AND EVALUATION

Project Leader: J. Pathak
(613) 996-5863

Person-Years: 2.1
A-Base Operating and Maintenance: $124,000
Contracts: Nil

Objective:

On a continuing basis, to develop and evaluate mineability and mine operational economic criteria for hardrock mining in Canada, and to prepare estimates, on an annual basis, of planned and projected production capabilities of uranium mines.

On a demand basis, to make technical/economical evaluations of mining project proposals submitted by outside departments or agencies.

Background:

Technical and economic evaluation of existing and potential uranium mining operations is an essential component of uranium ore reserve and resource assessment. This responsibility has been assigned to CANMET on behalf of the EMR Energy Policy Sector. In addition, reliable estimates of uranium production capabilities for individual properties, plus projections of future production, are also required for the EMR Uranium Resource Appraisal Group (URAG). The resulting information on Canadian uranium ore reserves, resources and production is required as input for policy decision-making on domestic and export sales quotas for each projected and operating unit in Canada, as well as for the granting of production licences by AECB.

To meet the above commitments it is essential for CANMET to acquire realistic production cost data to develop adequate mine operations evaluation procedures and to establish a base of unit productivities related to existing and developing mining technologies. Computer techniques will be used where feasible.

Fortunately, the development of such data bases and expertise is generally applicable to all hardrock mining operations and, therefore, one result of this work will be a general mine evaluation capability in MRL/CANMET, which will be of value to government policy organizations, as well as the Canadian mining industry.

Technology Transfer:

URAG operations require close working relationships with many Canadian mining operations, as well as those operations with production potential. In addition, specific mine evaluation exercises can be expected to be required for other hardrock mining operations, for government policy purposes, and these will involve personal contacts within the industrial sector.

Publications summarizing the development of new evaluation techniques are projected to transfer relevant information to the Canadian mining industry.

Computer cost data for the evaluation of small underground hardrock mining operations will be developed, and this information will be made available to the industry.

Planned Activities for FY 1988/89:

1. Report annually on Canadian uranium production capability by deposit (report produced in May of every year).

2. Completion of critical reviews of mining proposals/feasibility studies on a demand basis.

ADVANCED MINE EQUIPMENT TECHNOLOGY

Project Leader: J. Pathak
(613) 996-5863

Person-Years: 2.0
A-Base Operating and Maintenance: $124,000
Contracts: $65,000 (A-Base) $121,000 (MDA)

Objective:

To assess the impacts of worldwide developments in new mining equipment and other pertinent advanced technologies, e.g., automation and robotics on mine productivity; to prepare state-of-the-art review on equipment and promote the development of new mine equipment systems; and to assess and demonstrate dust control measures and environmental monitoring systems in hardrock mines.

Background:

To improve the competitiveness of the Canadian mining industry, MRL is concentrating its research efforts in projects related to enhancement of productivity and improving safety in mines. The application of microprocessors, sensors, data transmission, monitoring and control systems are increasingly used to enhance productivity and safety.

During the past few years, MRL has been very active in monitoring and control of air quality in dieselized mines. Recently, MRL has completed in-house work for the performance evaluation of a real-time monitoring system using multiple sensors. This system is being now moved to a salt mine to monitor methane emissions. Other studies include monitoring CO_2 in a ventilation network. The CO_2 gas, used as surrogate gas for other pollutants, could provide a simple measurement to monitor overall air quality.

These projects involve both cost-sharing and cost-recovery.

Technology Transfer:

1. The MRL work done on real-time monitoring of various pollutants (gases), evaluation of various sensors and air quality is directly transferable to underground mines in Canada.

2. The blasting simulation program, presently 65% complete, will be available to the industry for designing optimum blasts for VBM mining.

Planned Activities for FY 1988/89:

1. MRL noise and vibration research reports - The complete collection of outputs produced during the life of the project will be compiled, with an introduction and summary.

Progress reports on:

2. Study on the application and development of dust control techniques for various mining equipment (drilling) and methods.

3. The use of CO_2 as a surrogate for diesel emissions.

4. Study of environmental problems related to methane emissions in a salt mine.

5. Optimization of blast design for blasthole operations in Manitoba mines.

CANADIAN MINE TECHNOLOGY COORDINATION

Project Leader: J. Pathak
(613) 996-5863

Person-Years: 1.3
A-Base Operating and Maintenance: $75,000
Contracts: $348,000 MDA

Objective:

To promote cooperation and improve efficiency in the Canadian mining industry by maintaining a national information bank on current and developing mining technology, and preparing state-of-the-art reports on mine operational problems.

Background:

Some of the more progressive mining companies are actively collaborating with consulting firms, equipment manufacturers, universities, Government R&D laboratories, research foundations, and other research delivery organizations in order to improve and develop mining technology. Many companies are also carrying out in-house research which is aimed at improving their own operations, but which could be applied to other operations in Canada. Because the results are generally not published, or made known to potential beneficiaries, the technological impact of their research is not always felt across Canada. To disseminate this knowledge, MRL has undertaken to collect, information on the research/project activities of these organizations, compile this in a suitable format, and distribute it to the mining industry. This will be a valuable contribution to the development of mining technology in Canada.

Technology Transfer:

The essence of this project is technological interchange amongst all Canadian organizations that are interested in mining research and mining technology development.

Planned Activities for FY 1988/89:

1. Collection of information and preparation of **"Index of Mining Technology Projects"** on an annual basis.

2. Development and modification of a reliable environmental monitoring and control system based on the results from an actual operating system in a mine.

MATERIALS HANDLING AND OPERATIONS RESEARCH

Project Leader: N. Billette
(613) 996-8615

Person-Years: 2.7
A-Base Operating and Maintenance: $154,000
Contracts: $10,000

Objective:

To develop the concepts of optimizing materials handling systems for both underground and open pit mines; to develop mathematical models for calculation of heat transfer in different media and mine segments; to apply computer techniques/graphics/simulation for optimization of various mine functions, and to improve mine design capability.

As part of a study to modify an existing program, which permits haulage selection to optimize blending for use with polymetallic mine deposits; carry out reserve studies of suitable deposits to accurately establish the grade and spacial distribution of metals and minerals and and to establish functional relationships between individual metals and minerals taking into consideration their physical/chemical properties.

Background:

Since the start of the metals price depression in the early 1980's, the Canadian mining industry has realized that it needs to move ahead of the world mining technology in order to maintain its competitive edge. Beside deployment of reliable and proven equipment, application of mathematical modelling (OR) and computers could optimize utilization of mine equipment, such as truck transportation or trolley-assisted haulage system in open pit mining, enhancing productivity. Automation and robotization of trucks in open pits could mean a savings of $150,000 to $200,000 per operating truck.

Other avenues where an impact on time and skilled labour saving could be made is the development of a CAD/CAM equivalent system for mine design. This could also optimize expensive mine development. The objective of the project will be to increase the usage of computers and better management information techniques, which already exist in the manufacturing and process industry.

Technology Transfer:

Some of the work undertaken will be site-specific with participation of operators with the results transferable to others. Most of the software developed will be user-friendly and will be based on the most commonly used PCs in the mines. All of the research carried out will be of an "applied" nature aimed at direct use by operators.

Planned Activities for FY 1988/89:

1. Haulage automation for open pit mines with integration of blending: a study on first polymetallic orebody planning procedures will be carried out and reported.

2. CAD system for small underground mines (3-dimensional) (1987-91); development of work plan.

3. Mine information systems programming - progress report on MDA contract.

4. Completion of demonstration projects on new improved open pit mine haulage technology.

5. Mathematical model for heat balance and recovery of heat from mine exhaust air and water.

6. Study report on second polymetallic deposit.

ROCK MECHANICS

MINE AND REGIONAL STABILITY

Project Leader: D.G.F. Hedley
(705) 848-2236

Person-Years: 3.0
A-Base Operating and Maintenance: $196,000
Contracts: Nil

Objective:

To evaluate pillar stability on a local and regional scale in Canadian hardrock mines; determine pre-mining stresses in rockburst-prone mines and in mine structures, especially around weakness planes.

Background:

CANMET has maintained an extensive program of rock mechanics R&D over the years. The prime thrust of this work in underground hardrock mines has been to improve safety of underground mine operations, both in the immediate local sense and for mine districts; while contributing to mining method advances which permit improved productivity.

Guidelines for design and operating parameters relating to rock structures in mines have been developed and implemented at mines as a result of this research. At present, mines are extending to greater depths. Improved productivity will result from applications of new bulk mining methods at depth.

Commensurate further developments in rock mechanics technology are also required. In particular, there is a need to develop a better theoretical base for design, and to lessen the dependency on empirical methods which are of limited use for predicting rock behaviour in new situations.

High ground stresses are encountered in mines at depth and where relatively high extraction ratios concentrate existing ground stresses. The end results of these high stresses can be pillar failures, either gradually, or violently in the form of rockbursts.

In recent years, computer programs have been developed which are capable of reasonably predicting stresses on fairly complex mining layouts. The other side of the coin, predicting rock strength, is still empirically-based to a large extent. More research is required, especially using stiff-testing machines to determine post-failure rock behaviour and its potential for rockbursting.

Technology Transfer:

The following methods of technology transfer will be used based on past practices:

1. Joint projects with industry;

2. Meetings with company, union, regulatory officials;

3. Jointly authored technical reports with industry;

4. Participation in industrial seminars.

Participants in this project are Campbell Red Lake Mine Limited, Rio Algom Limited, Denison Mines Limited, INCO Limited, Falconbridge Limited, Lac Minerals Limited.

Planned Activities for FY 1988/89:

1. Diamond drilling into the fractured zone above the Quirke Mine.

2. Evaluation of pre-mining ground stresses at some hard rock mines in the Canadian Shield.

3. Stress measurements at the Montauban Mine, Québec

4. Stress measurements at the Dome Mine, Timmins.

5. Multi-specimen tests in a stiff testing machine to evaluate the mechanism of violent or non-violent pillar failures in underground mines.

ROCK MASS CHARACTERIZATION

Project Leader: M. Bétournay
(613) 995-1147

Person-Years: 2.5
A-Base Operating and Maintenance: $143,000
Contracts: $125,000

Objective:

To evaluate the influence of geomechanical factors and support systems on the stability/failure mechanisms of gravity-loaded rock masses, especially surface crown pillars.

Background:

The Selbaie Mine represents an extreme example of surface crown pillar conditions. Well fractured and highly altered, it represents a challenge to the safe and economical extraction envisaged. The contracts awarded to MIRZA Engineering will cover sampling, testing, modelling and monitoring aspects of the stability of the surface crown pillar. It will also identify the critical parameters to consider for design in such settings. The pillar will also be designed for recovery under 40m of over burden.

It is recognized that some specific structures in mining have special stability and support requirements. In these cases, such as for surface crown pillars, special attention is required to delineate the reasons for stability/instability and to select the best methods available to determine critical parameters required to evaluate stability and support requirements in the context of the operator's mining activity.

When properly included in a valid design approach, for surface crown pillars, rock mass characterization provides the focus for dealing with failure modes and the application of design methods. Because of the uniqueness of these mine structures, in a material and comparative sense, such characterization must employ methods and equipment used in the fields of mining and civil engineering and would benefit from the availability of a specific surface crown pillar characterization system. Such a system would be applicable to the large, multiple openings common in mining and would supply an understanding of how the rock mass interacts with support systems such as backfill.

A multi-year program is underway to develop, with the cooperation of the mining industry, crown pillar design guidelines. Assemblage of a comprehensive set of case histories, a significant component of the guidelines, will be completed shortly.

Technology Transfer

All of the work performed by the contractor is original and will establish new methods of sampling weathered rock and new ways of

modelling using a soil-rock numerical model. New monitoring techniques will also be tested for this terrain. New mining techniques are also being studied.

The resulting technology will benefit any future or presently operating mine with similar problems which, before the contract, had no way of obtaining or evaluating data on the crucial parameters related to such conditions.

The surface crown pillar handbook will have a significant impact on the ability to address all of the technical aspects of crown pillar design. Previously, there was a notorious lack of information on the subject.

The handbook, by combining the information from different fields and various case studies, will provide the operator with all of the tools: recognition of key elements for design, step-by-step procedure for site investigation, data analysis, analytical and modelling techniques, support measures, monitoring, etc., including advantages, disadvantages and limitations so that one can choose in accordance with needs.

CANMET is also sponsoring and developing original research, such as modelling, field sampling, investigations, and monitoring techniques. The resulting technology, provided in the form of CANMET reports, scientific publications and oral presentations, will benefit any future or presently-operating mine with crown pillar problems.

Planned Activities for FY 1988/89:

1. Report on the evaluation of support systems, including backfill, for weak rock masses.

2. Report on the design of surface crown pillars in severely altered rock masses.

3. Publish a guide for the safe and economic design of surface crown pillars.

ROCK PROPERTIES AND SUPPORT SYSTEMS

Project Leader: M. Gyenge
(613) 996-4006

Person-Years: 2.5
A-Base Operating and Maintenance: $173,000
Contracts: Nil

Objective:

On a continuing basis: to establish the strength, deformational, and other properties of the rock types encountered in research investigations and of those which are common at other Canadian mine sites; to report on the significance of rock matrix properties in relation to the occurrence of rockbursts; and, to publish the first volume of compiled design data for Canadian mine rocks.

Background:

Active mining at an increasing number of underground mines involves stress conditions where the post-peak strength properties of the rock must be taken into account in ground control investigations.

Mine structural and stability analyses by numerical modelling is an important stage in the process of mine design and planning. The result of these analyses influence the choice of mining methods and layouts, the support system and backfill requirements.

The stability analyses and design activities require reliable rock mass data. The most essential data are the peak and the residual strength envelopes of the rock mass.

The Canadian Mine Technology Laboratory (CMTL), by using the recently acquisitioned computer controlled servo hydraulic test facility, is now capable of providing the data required for underground stability analysis and design.

The rock mass property design data are to be established with first priority given to those rock types which were encountered at the sites of the ongoing research projects. In parallel, laboratory tests will also be conducted on those rock types which are most common in other Canadian mines.

The test results are to be summarized in a suitable standardized report format, which will include the geologic description of the sampled formation, the established strength envelopes and other mechanical properties data of the rock mass which are required for underground stability analysis and design.

Technology Transfer:

The following methods of technology transfer, proved to be effective, will be used:

1. Technical reports, publications, workshops on the results obtained by the joint projects with the industry.

2. The underground design data established by the test program to be compiled and published within the appropriate CANMET series of publications (e.g. Underground Mining Manual), which will be updated annually by the continuously established latest data.

Planned Activities for FY 1988/89:

1. Publication of guidelines for laboratory test procedures for rocks.

2. Report on parameters affecting rockbursts.

NUMERICAL MODEL DEVELOPMENT

Project Leader: Y. Yu
(613) 996-1890

Person-Years: 4.6
A-Base Operating and Maintenance: $315,000
Contracts: Nil

Objective:

On a continuing basis: to conduct studies related to mining; to develop guidelines for designing underground openings; develop numerical models and software packages in a form which is suitable for use with either personal or micro-computers at small mining operations; and, to implement new computer models for evaluating stability of underground openings and mining-related structures.

Background:

In mining, the prediction and evaluation of rock mass behaviour is becoming progressively more important in mine design and planning. This is especially so for selecting mining methods, layouts, stope and pillar dimensions, and mining sequence; as well as for ground control and support requirements. The explicit theoretical solutions are usually not available and, perhaps, are extremely difficult or impossible to obtain because the ground characteristics are always complex.

The complexity depends, among other factors, on geological structural features, rock types, and mine geometry. Physical models are expensive, take time to make, and are impractical and unreliable. Numerical models are desirable and are being accepted as alternative methods for determining stresses and displacements induced in the rock mass as a result of mining. There is a need to develop and implement numerical models based on the combination of the principles of modern rock mechanics and practical rock engineering in order to provide a reliable means for predicting ground behaviour of both underground and open pit, in a more scientific and rational manner.

Technology Transfer:

The following methods of technology transfer are foreseen:

1. Applications of numerical modelling techniques to mine design on joint projects with the mining industry.

2. Provision of software packages.

3. Preparation of technical reports, publication of significant results in journals, and attendance at conferences.

4. Conduct technology transfer seminars on numerical modelling techniques aimed for small Canadian Mines (subject to the availability of funding).

Planned Activities for FY 1988/89:

1. Stability evaluations of Canadian mines involved in CANMET's Cooperative Research Projects.

2. Attempt to verify certain numerical techniques for analyzing mine structures using field measurements.

3. Design guidelines for underground mine openings.

UNDERGROUND NUCLEAR WASTE REPOSITORY

Project Leader: M. Gyenge
(613) 996-4006

Person-Years: 2.5
A-Base Operating and Maintenance: $158,000
Contracts: Nil

Objective:

To determine the thermal-mechanical properties of rocks from study areas in the nuclear waste management programs, including determining micro-crack orientation through triaxial loading of over-cored CSIR samples; studying scale effects on the ambient temperature mechanical properties of rock samples from Lac du Bonnet; conducting mechanical property characterization of rock types of specific interest to AECL modellers; and preparing geotechnical program documents in support of concept submission by AECL.

Background:

Nuclear waste disposal, particularly of spent fuel rods, will become a critical aspect of nuclear electricity generation. CANMET's program is a part of Atomic Energy of Canada Ltd's long-term strategy for investigating disposal at depth in stable geological formations. CANMET's geotechnical and mineralogical expertise is required and used to determine how rock behaves under the high temperatures associated with decaying radioactivity.

Technology Transfer:

Methodologies and data will be incorporated into submissions made to regulatory agencies for approval of the concept of deep disposal of nuclear waste in plutonic structures. In the interim, regular yearly open meetings with the geoscience community, yearly review by an expert geoscience review committee, reports and publications are the methods of technology transfer.

Planning Activities for FY 1988/89:

1. Triaxial tests on over-cored CSIR samples.

2. Ambient temperature scale effects tests on URL core.

3. Mechanical property characterization of rock types of specific interest.

INSTRUMENTATION DEVELOPMENT

Project Leader: G. Herget
(613) 996-4027

Person-Years: 1.0
A-Base Operating and Maintenance: $110,000
Contracts: Nil

Objective:

To develop and test geotechnical field instrumentation to monitor ground reaction due to mining to promote safe operations and confirm planning assumptions.

Background:

A wide variety of instrumentation has been developed over the years but very little objective testing and field evaluation has been carried out. MRL is in the unique position of having mine access and know how to evaluate various types of instrumentations with regard to performance criteria and usefulness. New developments as required for borehole inspection by small diameter T.V. cameras will assist in stability assessments for excavation roofs and evaluation of design assumptions.

In addition, stress monitoring equipment for boreholes needs to be developed. A study is also necessary to identify, for potash mine design, suitable instrumentation for field exploration of deformation modulus and creep data.

Technology Transfer:

1. Publication in mining journals.

2. Seminars in mining camps.

3. Demonstration to equipment manufacturers.

Planning Activities for FY 1988/89:

1. Development of long-term high precision deformation monitoring equipment for boreholes in hard rock.

2. Development of long-term high precision deformation monitoring equipment for boreholes in soft rock.

3. Development of an electronic data acquisition system to monitor ground reactions to mining and suitable for analysis by personal computers.

MANITOBA MINERAL DEVELOPMENT AGREEMENT

Project Leader: R.W.D. Clarke
(613) 996-0360

Person-Years: 0.4
A-Base Operating and Maintenance: $40,000
Contracts: $311,000 MDA

Objective:

By 1989, to develop Vertical Block Method (VBM) design guidelines; safer procedures for scaling loose rock; a geotechnical data base and numerical package for the design of underground openings at depth; ground stability evaluation criteria for en echelon lensed ore-bodies; to identify and demonstrate the use of an underground communication system based on existing technology.

Background:

New mining techniques, such as vertical blasthole methods, create large expanses of hanging wall (and footwall) not found in cut and fill stoping. It is essential to predict how the ground will behave before it is mined. Modelling is the key to relating pre-mined strength and inherent stresses to the post-mined configuration and is predicated on information which details rockmass character. This type of planning allows many "runs" to test various parameters and their sensitivities.

To properly control the ground a better understanding of ground behaviour and its response to mining and the causes of instability is considered essential. Therefore, studies in the area of rock mass behaviour, mine stability, sophisticated numerical modelling, and improved mining technology are planned.

In underground mines, there is also a need for more effective communication systems. Current warning systems of fire hazards, in which stench gas is injected into mine air, are inadequate for remote working areas located at the ends of long ventilation systems. A reliable communication system which permits underground personnel to maintain communications almost anywhere within the mine, and with the surface, will be installed and evaluated.

A communications system for voice and data also completes the requisite infrastructure for automation of underground mobile equipment.

Technology Transfer:

The following methods of technology transfer are envisaged:

1. Preparation of technical/contract reports, and/or publication of results in scientific journals.

2. Technology transfer seminars or contract debriefing sessions.

Planned Activities for FY 1988/89:

1. Publication of a report dealing with U/C voice communications and system modifications.

2. Completion of underground communications systems contract.

3. Completion of underground stability evaluation with particular reference to en echelon lensed orebodies.

4. Completion of a geotechnical database and a numerical modelling package for the design of underground openings at depth.

5. Completion of VBM design guidelines contracts.

ROCKBURST RESEARCH

Project Leader: D.G.F. Hedley
(705) 848-2236

Person-Years: 5.0
A-Base Operating and Maintenance: $310,000
Contracts: Nil

Objective:

To develop new seismic equipment and monitoring techniques for studying rockbursts in hardrock mines; carry out seismic studies at mines in Sudbudy, and other Ontario locations; relate seismic activity to stress, displacement and fill pressures at these mines.

This research is part of the Canada/Ontario/Industry Rockburst Project.

Background:

CANMET has maintained an extensive program of rock mechanics R&D over the years. The prime thrust of this work in underground hardrock mines has been to improve safety and productivity. Design guidelines have been developed for a number of mining methods and support techniques.

In 1985, a Memorandum of Agreement was signed between Canada/Ontario/Mining Industry for a five-year rockburst research project with tripartite funding.

Rockbursts, such as occur in the Canadian pre-Cambrian Shield, are attributed to stress redistributions which accompany mining in hard rock formations. Miscroseismic activity, which accompanies the stress increase preceding a rockburst, is viewed as having the potential to locate areas in which rockbursts may occur and, perhaps, to provide a means of short-term prediction prior to occurrence.

Although miscroseismic systems have been used experimentally in mines for many years, marginal advances in methodology and equipment development have limited their use. This is attributed in part to mine utilization philosophy, staff turnover, and the limited market for equipment which could be developed.

Source location is the objective of the existing, or planned, ten Canadian microseismic systems. The research on rockbursts, which is proposed, would involve investigation, development and testing of equipment and methodologies directed at improving the location of microseismic build-up, identifying the mechanisms of energy release, and, in some cases, warning of impending rockbursts.

The first two years of the rockburst project were mainly concerned with developing new seismic instrumentation which incorporates wave-form analysis. These systems, along with other more conventional rock

mechanics instrumentation, will be tested at mines in Red Lake, Kirkland Lake and Sudbury.

In addition to this basic microseismic research, work will continue on measurement and analysis of stress and displacement and computer modelling in hardrock mines.

Technology Transfer:

The following methods of technology transfer will be used based on past practices:

1. Joint projects with industry;

2. Meetings with company, union, regulatory officials;

3. Jointly authored technical reports with industry;

4. Participation in industrial seminars.

ONTARIO MINERAL DEVELOPMENT AGREEMENT

Project Leader: R.W.D. Clarke
(613) 996-0360

Person-Years: 1.0
A-Base Operating and Maintenance: Nil/$37,000 MDA
Contracts: $534,000 MDA

Objective:

To improve productivity and safety in underground hardrock mines by optimizing the support capabilities, placement techniques and engineering design procedures for both sand and rock backfills; and, to develop a specialized backfill laboratory at Sudbury.

Background:

The current directions in the Ontario Mineral Development Agreement research are based on the amount of backfill used and planned to be used in the industry, and on the high cost of present consolidating agents. If modelling, and hence planning, can offer improved stability by determining optimal placement strategies in the mining cycle, and if a detailed investigation of backfill engineering properties can yield cheaper, stiffer backfills, then the resultant economies will add to reserves in areas where the development cost has already been paid. At the same time, computing has revolutionized every aspect of engineering and management.

The Canada/Ontario Mineral Development Agreement (COMDA) recognizes the need for a unified direction in program creation by issuing a contract on computer specifications. The industry has been plagued with a myriad of "solutions" which only run on some very specific hardware and, consequently, programs are not getting a wide enough trial to establish utility. The mining industry is being poorly served by software manufacturers. At the other end of the computing spectrum, large programs have seldom been within reach of the mining user. The need is clear because metal economics favours bulk methods and reserves are at depth in established mines. These forces have combined to promote a significant, new approach in three-dimensional modelling of entire orebodies.

Technology Transfer:

Talks based on completed COMDA projects will be given at a CANMET seminar, tentatively scheduled for the early fall of 1988.

The following methods of technology transfer will be used, based on past practices:

1. Joint projects with industry;

2. Meetings with company, union, and regulatory officials;

3. Jointly authored technical reports with industry;

4. Participation in industrial seminars.

Planned Activities for FY 1988/89:

1. Publication of Information/Technology Developed Through COMDA on dense fill delivery systems characteristics, and potential for liquifaction, publication also of monitoring and modelling of a cemented sill mat.

2. Report on use of cemented fills for controlling violent pillar failures.

FILL STUDIES (SUDBURY)

Project Leader: A. Annor
(705) 674-5008

Person-Years: 2.0
A-Base Operating and Maintenance: $175,000
Contracts: Nil

Objective:

To establish a specialized laboratory for studying the engineering and physical properties of mine backfill materials used in Canadian mining operations with the purpose of developing a manual on mine backfill technology.

Background:

Research into the support behaviour of mine backfill has recently been identified by the Canadian Mining industry as an essential requirement, to improve productivity and safety in mines. In this regard, several research projects on mine backfill are being carried out under the Canada/Ontario Mineral Development Agreement (COMDA).

CANMET's Sudbury Laboratory is dedicated to the testing of backfill materials and provides a supportive role to the COMDA work.

Technology Transfer:

The transfer of technology will be achieved through seminars and open meetings with the mining community as well as by means of reports and publications.

Planned Activities for FY 1988/89:

1. Establishment of Laboratory.

2. Installation, calibration and commissioning of laboratory equipment.

3. A review of current laboratory and in-situ test methods for establishing the physical and engineering properties of mine backfill materials.

EVAPORITE MINING METHODS

Project Leader: G. Herget
(613) 996-4027

Person-Years: 1.4
A-Base Operating and Maintenance: $80,000
Contracts: $136,000 MDA

Objective:

To increase potash recovery over current levels by carrying out contract research in the areas of ground control, safety and productivity, including predicting mine opening stability, subsidence, performance of backfill, blast design, and development of mine services software.

Background:

On May 17, 1983, the Minister of Energy, Mines and Resources announced the coming into force of the two (2) year START Program (Short-Term Aid in Research and Technology) to assist the Canadian mining industry.

One of the thrusts provided for under START covered research and development contracts with short-term industrial benefit. The current recovery rate of Saskatchewan potash is 28% to 38% and, though profitable, represents a significant loss of resources as well as profit due in part to increased underground transportation.

A two-year program of contract research under START ($250K/year) to aid the potash industry has been completed by MRL with the participation of the potash industry. A total of eight contracts which addressed questions of mine design ground control and monitoring of dust were completed. Technology transfer through seminars and workshops for potash mine design were completed in 1986 and 1987.

The two-year program allowed a much needed initiative and the potash industry has responded very well. However, further work has been necessary to allow definite suggestions to be developed on how to improve recovery. Additional work has been directed towards monitoring excavation behaviour in potash under controlled conditions and further development of numerical modelling capability. (Cominco Potash Mining Operation (1986/1988), IMB (1986/1987), Denison/Potacan (1986/1989).

Technology Transfer

1. Seminars, publications and CANMET reports.

Planned Activities for FY 1988/89:

1. Report on the monitoring of excavation behaviour at Cominco.

2. Completion of numerical analyses for a new mining layout incorporating backfill (New Brunswick MDA).

3. Application of SPASID subsidence model to Saskatchewan conditions.

4. Development of a new approach for mining Saskatchewan potash.

ROCK MECHANICS EXPERT SYSTEMS

Project Leader: S. Vongpaisal
(613) 996-4302

Person-Years: 0.7
A-Base Operating and Maintenance: Nil
Contracts: Nil

Objective:

To develop and build rock mechanics expert systems as a powerful tool for use in mine design, planning, and ground control in order to improve safety and productivity.

Background:

In the past 25 years, technical advances and studies in rock mechanics have generated a great deal of information around the world, with regard to mining dimension and methods. It is difficult and expensive to retrieve the relevant information.

With the current development of the powerful computer systems known as "expert" or "knowledge-based" systems, it becomes possible to effectively and efficiently harvest the wealth of such information and to store it in a data base. The system can be built in such a way that it can be utilized as a powerful tool in solving mining engineering problems and in improving mine safety and productivity. It will also lead to standardized reporting of site-specific data.

Technology Transfer

1. Preparation of technical report, and/or publication of results in scientific and mining journals.

2. Provision of expert system packages to mining industry.

3. Technology transfer seminars.

Planned Activities for FY 1988/89:

1. State-of-the-art review.

2. Building and compiling databases.

3. Building expert system prototype.

MINERAL RESERVES ASSESSMENT

RESERVE ASSESSMENTS

Project Leader: A. Füstös
(613) 996-8519

Person-Years: 2.0
A-Base Operating and Maintenance: $104,000
Contracts: Nil

Objective:

To provide regular updates of economically mineable uranium reserves and associated inferred resources; determine the ore reserves of specified mineral deposits to meet departmental information requirements; and develop new ore reserve evaluation methodologies for the assessment of reserves and related economic evaluations.

Background:

The determination of uranium reserves and associated inferred resources in Canadian deposits was assigned to MRL/CANMET by Cabinet Order in 1974. For reliable uranium resource and reserve assessments it was necessary to obtain primary core drilling data from all companies with relevant deposits. Over the subsequent years this has been done. For computer storage of such data and the required assessment calculations and evaluations, it was necessary to develop two parallel sequences of reserve assessment computer programs (CADD and GEM). Over time this has been done and the complete sets of programs are now being made available to the public.

Only economically mineable reserves and resources of uranium in Canada are included in confidential national reports, as the basis for annual published aggregated results. Accordingly, it has been necessary to estimate mining costs based on simple economic prices, assigned by URAG, which are used to establish lower limit cutoff grades for reserve assessment.

Independently estimated mineable uranium reserves and resources are required as input to government (URAG) policy decisions on domestic and export quotas for Canadian utilities and uranium producing operations, as well as the granting of licences by AECB. In addition, projections of future Canadian uranium production by companies are required internally, as well as in aggregated form for international agencies such as the International Atomic Energy Agency (IAEA).

Technology Transfer

Each uranium reserve and resource assessment by MRL Ore Reserve Group, on behalf of URAG, is reviewed with individual staff representatives of relevant individual company exploration or mining projects. All procedures and results are shared and questions pertaining to methodology are resolved.

All assessment procedures and related computer programs, which have been developed by MRL Ore Reserve Group, are passed to appropriate staff

members of uranium exploration and mining companies. Meetings are arranged to review procedures pertinent to each specific situation and to ensure that technology transfer occurs in a meaningful way.

As noted, all of the programs developed to date for uranium reserve and resource assessment are now being made available to the public.

Planned Activities for FY 1988/89:

1. Periodic reports on Canadian uranium reserves deposit-by-deposit, including significant general information on the status of each.

2. Report of new computer-based methodologies for evaluating uranium and other mineral reserves and resources, including procedures utilizing conventional, geostatistical and global statistical multiple cut-off systems.

MINE ENVIRONMENT

VENTILATION AND RESPIRABLE DUST

Project Leader: J. Bigu
(705) 848-2236

Person-Years: 4.0
A-Base Operating and Maintenance: $261,000
Contracts: $20,000 A-Base
6,500 MDA

Objective:

To establish a dust tunnel at the Elliot Lake Laboratory for instrument evaluation and for studies of airborne particulate contaminants; carry out studies in mines on dust conditions, ventilation and to determine their relationship; determine the concentrations of mineral particulates in mine air at various locations and for various mining operations; to investigate dust control measures; and, demonstrate continuous dust and ventilation monitoring systems underground.

Background:

Dust is a significant factor affecting the long-term health of the work force in all mining operations. Dust from certain minerals can lead to lung disease. Lubricating oil mists and diesel exhaust also carry noxious dust and gases. In addition, in uranium mines, dust particles can carry radon and thoron daughters, and mostly alpha-particles, emitted internally may give rise to tissue damage.

There is a need to improve measurement techniques, i.e. instrumentation and methods, and programs to better assess and predict personal dust exposure among other factors, must be known in order to determine effective control measures and to guide and interpret epidemiological and medical studies. This work requires developing an extensive data base through sampling in mines with improved dust instrumentation. It also determines the performance, quality and accuracy of dust instrumentation.

Control measure efforts centre on improving breakage and rock handling techniques to minimize dispersion of dust into the air, filtration of airborne dust, wetting techniques, as well as optimizing mine layout and ventilation. Ultimately, optimizing mine layout and ventilation. Control requires appropriate dust suppression and control methods to be built directly into mine equipment and mining methods.

Technology Transfer:

Cooperation with mining companies is essential in much of the experimental work on this project, both through the use of operating mine facilities for collecting samples and through collaborative projects. Technology transfer is thus effected directly to the companies involved as well as through report dissemination, technical presentations, seminars and workshops. The data obtained are also made available to government agencies, federal and provincial, through the above channels.

Planned Activities for FY 1988/89:

1. Establishment and operation of new dust tunnel.

2. Evaluation of dust control methods in hardrock mines.

3. Evaluation of dust monitoring system in hardrock mines after sensor development.

4. Initiation and completion of project on the use of recirculation to reduce and/or control dust and diesel exhaust levels in ungerground mines.

RADIATION

Project Leader: J. Bigu
(705) 848-2236

Person-Years: 4.0
A-Base Operating and Maintenance: $250,000
Contracts: $20,000

Objective:

To establish a national calibration facility for instruments measuring radon, thoron and their decay products; characterize long-lived radioactive dust in underground uranium mines and mills; develop and evaluate radiation instrumentation and undertake radiation studies leading to control of radiation and better assessment of personal radiation dose exposure; develop radiation/aerosol/ventilation mine models for underground uranium and to test these models experimentally.

Background:

Radiation exposure of uranium mine personnel can be controlled basically by limiting the time of exposure, protecting the worker (e.g., shielding), and by reducing the radiation level. Ventilation is an effective way of reducing radiation levels at working sites. However, there are other methods that may prove to be both effective and economical in helping to control and/or minimize radiation levels.

Such methods include: (1) coating mine walls with certain chemical agents (sealants) to reduce radon and thoron migration through mine walls; (2) use of mixing fans to eliminate decay products by plate-out on the fan blades and on wall surfaces due to convective air currents set-up by the fan; (3) use of DC electric fields to remove decay products by electrostatic precipitation; and, (4) use, in certain cases, of special 'loose' filter materials with electret properties to remove decay products by mechanical trapping and electrostatic precipitation.

The measurement of mine radiation levels and exposure dose of workers is of upmost importance from the health physics, occupational and engineering standpoints. Furthermore, reliable experimental radiation data very much depends on adequate performance of monitoring instrumentation. Hence, proper testing procedures and calibration of radiation instruments are important.

In this light, the establishment of a large test facility for radon, thoron and their decay products is indispensable.

Finally, the International Commission on Radiological Protection (ICRP) has recently made recommendations regarding limits of exposure to long-lived radioactive dust, in relation to total dose exposure to external gamma-radiation and airborne alpha-emitters (i.e., radon and thoron daughters in the submicron and respirable range). Hence, identification and quantification of long-lived radioactive dust has become an important issue.

Technology Transfer:

Cooperation with mining companies is essential in much of the experimental work on this project, both through the use of operating mine facilities for collecting samples and through collaborative projects. Technology transfer is thus effected directly to the companies involved as well as through report dissemination, technical presentations, seminars and workshops. The data obtained are also made available to government agencies, federal and provincial, through the above channels.

Planned Activities for FY 1988/89:

1. Establishment and operation of the national calibration facility for radiation instrumentation.

2. Publication of work carried out at Denison Mines and St-Lawrence Fluorspar Ltd. (Nfld) in 1987/88.

3. Development, evaluation and demonstration of continuous radiation monitors, and other radiation instrumentation, for better assessment of personal dose exposure and control of radiation.

4. Evaluation of radiation control measures.

EXPLOSIVE ATMOSPHERES

FIRE AND EXPLOSION HAZARD R&D

Project Leader: E.D. Dainty
(613) 996-6285

Person-Years: 1.0 ERD
2.4 A-Base
A-Base Operating and Maintenance: $165,000
ERD Operating and Maintenance: $130,000
Contracts: $19,000 A-Base
$120,000 ERD

Objective:

To encourage, by means of in-house and contracted R&D, the development of improved equipment and materials to reduce risks to the safety of underground miners due to the presence of explosive mine gases and dusts, other industrial dusts and fire hazards.

Background:

During the past 1 1/2 years, a new dust laboratory has been constructed and state-of-the-art laboratory equipment for measuring various explosion parameters have been commissioned. These are to be used both for cost-recovery work and for research purposes. CANMET personnel are playing a lead role in a joint program with industry on the newly-recognized hazards of sulphide ore dust explosions.

Technology Transfer:

1. Scientific papers;
2. Internal reports;
3. Development of standards;
4. Verbal and written advice on explosion hazards;
5. Laboratory test reports (cost recovery).

Planned Activities for FY 1988/89:

1. Continue the study of the effects of scale on explosion parameters of Canadian dusts by external contract; develop a method for evaluating the thermite reaction hazard resulting from impact of light alloys.
2. Complete a comprehensive CANMET monograph on dust explosion control technology.

DIESEL FLAMEPROOF & EMISSIONS R&D

Project Leader: E.D. Dainty
(613) 996-6285

Person-Years: 3.6
A-Base Operating and Maintenance: $191,000
Contracts: $14,000

Objective:

To formalize the design criteria for venturi scrubbing systems for transfer of technology to the private sector; to finalize the form of the air quality index expression for ventilation prescription and environmental assessment; to characterize air quality in underground dieselized workings, and to complete the technology transfer aspect of diesel emissions reduction R&D and air quality control.

Background:

Past diesel emissions research has placed CEAL in a world-leading position in this field. Privatization of two diesel emissions reduction technologies is underway. As a result of specific interest from mine operators and regulatory authorities, emphasis is shifting from equipment development to the quality of the mining environment. This project will, therefore, involve not only finalization of emission reduction equipment application, but also contaminant measurement leading to ventilation control, and hopefully to automation of the systems having a beneficial impact on health as well as on operating costs. This project involves shared costs, matching funds, and cost recovery projects.

Technology Transfer:

CEAL is presently in the process of transferring up to five technologies to the private sector, including two diesel exhaust emissions reduction devices presently in process through the NRC/IRAP (PILP) program. These latter two are: (1) filtration technology involving application of the ceramic filter elements to an array of mining vehicles, and (2) high-efficiency venturi-type water scrubbing systems. These devices are being developed for use on both coal and metal mine vehicles, for both domestic application and export by 1989. The ceramic filter has met with considerable success in domestic and overseas mines during 1987 and 1988.

In addition, the planning process has begun for the privatization of: underground environment quality assessment technology; mine air quality control technology; and, a precise, multi-component gas/vapour mixture preparation apparatus in constant in-house use.

Planned Activities for FY 1988/89:

1. Continuance of ongoing in-house certification-related emissions R&D in collaboration with Canadian private sector firms and other government agencies.

2. Finalization of the AQI for ventilation prescription and environmental assessment (1988). Completion of a position paper by March 31, 1989.

3. Privatization/commercialization of venturi scrubbing systems.

4. Privatization/commercialization of ceramic filter systems.

5. Characterization of underground environment air quality in at least one dieselized working in 1988/89, in collaboration with the mine operators and regulatory authorities leading to automated control of mine ventilation systems.

EQUIPMENT SAFETY CERTIFICATION

EQUIPMENT CERTIFICATION AND TESTING

Project Leader: J.A. Bossert
(613) 996-4325

Person-Years: 4.0
A-Base Operating and Maintenance: $257,000
Contracts: Nil

Objective:

To provide, on a continuing basis, a certification service to Federal and Provincial Inspection authorities for apparatus and materials intended for use in underground mines.

To provide testing services in support of the certification service, as well as contract testing services to clients seeking evaluation of apparatus and materials for use in industries where explosive gas and/or dust hazards may exist.

Background:

The certification service was started in 1955 at the request of the Provincial Ministers of Mines, who saw a need for a Canadian certification service for equipment and materials for use in underground coal mines. This service is provided to manufacturers or users on a cost-recovery basis. The major outputs are certificates issued (currently about 80 per year) and a published list of certified products.

Whenever possible, these certificates are based upon conformance with national concensus standards. Because of EMR's involvement as a certifying body, our input is required (as committee members) in a number of technical committees.

Because there is no other organization in Canada performing testing services in explosive atmospheres, this service is also made available to other Canadian companies and organizations on a cost-recovery basis.

Technology Transfer:

1. Confidential reports on test results are made available to the submittors of equipment and materials.

2. A list of certified products is published annually and given wide distribution to the mining industry.

3. A report of our activities is given to the annual meeting of the Chief Inspectors of Mines.

4. Courses are given to mine inspectors and mine maintenance personnel on how to safely repair flameproof equipment.

5. Advice and guidance is given to designers of Canadian built flameproof equipment particularly those working under Federal government contracts.

Planning Activities for FY 1988/89:

1. Certificates for flameproof and intrinsically safe electrical equipment, gas detection equipment, diesel powered equipment, fire resistant materials (conveyor belts, electric cables, hydraulic fluids, ducts, etc.) for use in underground mines.

2. Annual list of certified equipment and materials for use in underground mines.

QUALITY ASSURANCE

Project Leader: G. Lobay
(613) 996-1902

Person-Years: 1.0
A-Base Operating and Maintenance: $55,000
Contracts: Nil

Objective:

To monitor the continuing compliance of apparatus and materials certified by EMR after certification, and to maintain a certification history of EMR certified products.

Background:

In 1984, EMR and the Canadian Standards Association signed a Memorandum of Understanding which included a provision for CEAL to utilize CSA's extensive factory inspection network which operates on a world-wide basis. This has enabled CEAL to set up a system of programmed factory inspections to ensure that certified equipment and materials continue to meet EMR's requirements after the certificate has been issued.

Technology Transfer:

1. Visit from an Inspector from CSA or CEAL;

2. Re-test of fire-resistant materials.

Planned Activities for FY 1988/89:

1. Annual visits to all manufacturers holding regular certificates for equipment and materials used in underground mines by membership on standards-writing committees and related research, and fostering of international standards.

STANDARDS DEVELOPMENT

Project Leader: J.A. Bossert
(613) 996-4325

Person-Years: 2.0
A-Base Operating and Maintenance: $109,000
Contracts: Nil

Objective:

To participate in the development of standards related to equipment and materials used in underground mines by membership on standards-writing committees and related research, and fostering of international standards.

Background:

As part of the equipment and materials certification for underground mines, Canadian standards are required in order that the certificates are based upon fair and reasonable requirements. CEAL participates in the writing of these standards by participation in technical committees operating on a National and International basis and, in addition, performs research studies on new test methods proposed in order to assist these committees in their deliberations.

Technology Transfer:

1. Reports of research on this subject are circulated as published to all interested parties including manufacturers, mine inspectors and mine owners.

2. CFAL personnel serve on technical committees of several recognized standards writing bodies including the International Electrotechnical Commission (IEC), International Standards Organization (ISO), Canadian Standards Association (CSA), Instrument Society of America (ISA), and Canadian Gas Association (CGA).

Planning Activities for FY 1988/89:

1. Draft Canadian standards currently under preparation, and eventually to be published as National Standards of Canada, include: mine ventilation materials and portable blasting machines.

2. International standards for electrical equipment for use in explosive atmospheres, fire-resistant hydraulic fluids and flame retardant conveyor belting.

3. Revision of existing standards to keep up with new technology.

ENVIRONMENTAL CONTROLS

MINE/MILL WASTE MANAGEMENT

Project Leader: N. Davé
(705) 848-2236

Person-Years: 3.0
A-Base Operating and Maintenance: $154,000
Contracts: Nil

Objective:

To develop methods/technology for the management of mine/mill waste to reduce environmental impact.

Background:

The development of methods for the minimization of the environmental impact of mine/mill waste involves both laboratory and field investigations. The Elliot Lake Laboratory of CANMET is uniquely situated to undertake studies on the methods for the safe disposal of mine/mill wastes, surface stabilization by vegetative cover, and environmental pathways for contaminants migration.

The disposal technique may be the conventional land-based tailings management system, in which the tailings surface and effluent will require treatment to reduce the effects of weathering and other natural forces. In some special cases the disposal may be underwater in deep lakes to minimize the oxidation of metal sulphides, in which case the stability under the applicable conditions must be known. Suitability of vegetative cover and other chemical surface stabilization techniques have to be evaluated for land-based management systems for their role in minimizing leaching, contaminant migration via surface and groundwater flow regimes and uptake of contaminants by the plants and various other inhabitants of the waste management system.

CANMET's role will consist of demonstration and evaluation of methods such as vegetation and other engineered covers on tailings for monitoring their effectiveness, identifying and evaluating the mechanisms which tend to control the release of environmental contaminants through soil development, water movement, and food chain pathways.

The knowledge acquired from these studies will assist federal and provincial government agencies in the formulations of policies for the development of mineral resources which will permit enjoyment of their socioeconomic benefits without leaving a legacy of environmental despoliation and human health hazards in the near future.

The base metals and uranium mining companies will benefit from the results of this project, including Provincial and Federal Governments through their financial holdings in some of these.

Technology Transfer:

Through reports, publications, seminars and work shops.

Planned Activities for FY 1988/89:

1. Evaluation of the geochemistry of thickened tailings disposal system.

2. Consolidation of tailings using lime, cement and slag cement for in situ and back filling operations.

3. Study of physical and chemical profiles of uranium and sulphide tailings basins.

4. Study of solution transport and contaminants migration pathways from uranium and sulphide tailings.

APPENDIX A

Contractor: Mining Resource Engineering Limited

Scientific Authority: R.R. Vandebeek

Title: Development of Improved Quantity-Distance Storage Requirements for Propellants

Contract Value: $65,920

Contractor: Mining Resource Engineering Limited

Scientific Authority: K.K. Feng

Title: Theoretical Model for Predicting Low Velocity Impact Sensitivity Bubble Sensitized Slurry Explosion

Contract Value: $105,000

Contractor: Cominco Limited

Scientific Authority: G. Herget

Title: To Carry Out Field & Laboratory Testing, Field Measurements & Numerical Modelling of Excavations in Potash

Contract Value: $90,000

Contractor: L'Association des Mines et Matériaux de Québec

Scientific Authority: N. Billette

Title: Influence of Diverse Variables, Including the Bonus Factor, Upon Underground Mining Reproductivity in Québec (UP-A7-007) (Cost Shared)

Contract Value: $45,240

Contractor: Central Canada Potash

Scientific Authority: S. Vongpaisal

Title: Regional Subsidence Related to Potash Mining

Contract Value: $50,000

Contractor: TO TENDER

Scientific Authority: L.B. Geller

Title: Evaluation of Improved Methods for the Non-Destructive Testing of Mine-Shaft Wire-Ropes

Contract Value: $180,000

Contractor: University of Saskatchewan

Scientific Authority: S. Vongpaisal

Title: Salt Anomaly Prediction: Phase I - To Obtain Improved Understanding of Salt Anomalies in Potash Mines to Develop Capacity to Predict Their Occurrence.

Contract Value: $30,000

Contractor: Denison Potacan Potash

Scientific Authority: G. Herget

Title: Hanging Wall Response to Mining at Denison-Potacan

Contract Value: $63,370

Contractor: Denison Potacan Potash Co.

Scientific Authority: G. Herget

Title: New Brunswick MDA - Backfill Mining Trial

Contract Value: $199,130

Contractor: INCO Limited

Scientific Authority: A. Annor

Title: Ontario MDA, Part II: In Situ Determination of Dewatered Tailings Fill Properties in Ontario Mines

Contract Value: $112,000

Contractor: Denison Mines Limited

Scientific Authority: D. Hedley

Title: Ontario MDA, Task 3: Use of Consolidated Fills for Controlling Violent Pillar Failure in Ontario Mines

Contract Value: $610,000

Contractor: Falconbridge Limited

Scientific Authority: A. Annor

Title: Ontario MDA, Task 5: In Situ Properties of Backfill Alternatives in Ontario Mines

Contract Value: $470,000

Contractor: INCO Limited

Scientific Authority: Y.S. Yu

Title: Ontario MDA: Simulation of Bulk Mining at Depth with Backfill in Ontario Mines

Contract Value: $1,000,000

Contractor: Queen's University

Scientific Authority: M. Bétournay

Title: Seismic Characterization (UP-07-001)

Contract Value: $289,770

Contractor: Les Mines Selbaie

Scientific Authority: M. Bétournay

Title: Recovery of Surface Crown Pillars at Les Mines Selbaie Using Controlled Caving Methods (UP-S7-010) (61/39 Cost Shared)

Contract Value: $93,100

Contractor: TO TENDER

Scientific Authority: R.W. Clarke

Title: Blast Design Optimization and Control

Contract Value: $200,000

Contractor: Sherritt Gordon Mines

Scientific Authority: S. Vongpaisal

Title: Manitoba MDA, Task 2: Ground Stability Evaluation with Reference to En Echelon Lensed Orebody

Contract Value: $289,100

Contractor: Sherrit Gordon Mines

Scientific Authority: S. Vongpaisal

Title: Manitoba MDA, Task 3: Communication System for Isolated Areas in Mines

Contract Value: $429,400

Contractor: INCO Limited

Scientific Authority: Y.S. Yu

Title: Manitoba MDA, Task 4: Ceomechanical Data Base for Ground Control in Deep Mines

Contract Value: $255,550

Contractor: INCO Limited

Scientific Authority: Y.S. Yu

Title: Manitoba MDA, Task 1: Develop Vertical Block Method Design Guidelines for Steeply Dipping Orebody Techniques

Contract Value: $362,500

Contractor: INCO Limited

Scientific Authority: J. Pathak

Title: Manitoba MDA, Part III, Task 5: Optimization of Blast Design for Blasthole Mining Operators

Contract Value: $260,000

Contractor: Noranda Research Centre

Scientific Authority: E.D. Dainty

Title: Continuous Analysis of Gases and Dust Before, During and After Blasting in Canadian Sulphide Ore Deposits

Contract Value: $96,000

Contractor: Ian W. French & Assoc.

Scientific Authority: J.P. Mogan

Title: Addendum to 'Health Implications of Exposure of Underground Mine Workers To Diesel Exhaust Emissions - Update'

Contract Value: $20,150

Contractor: Laurentian University

Scientific Authority: E.D. Dainty

Title: Determination Levels of Dinitropyrenes on Diesel Particulate Exhibiting Excess Mutagenic Activity

Contract Value: $22,210

Contractor: TO TENDER

Scientific Authority: N. Davé

Title: Field Sampling Manual for Reactive Sulphide Tailings (RATS)

Contract Value: $30,000

Contractor:	TO TENDER
Scientific Authority:	N. Davé
Title:	Manual of Methods Used in Revegetation of Reactive Sulphide Tailings Basins
Contract Value:	$35,000